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THE PROBLEM OF INDIVIDUAL DIFFERENCES IN THE TEACHING OF SECONDARY-SCHOOL MATHEMATICS

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In the October number of the *School Review*[1] the writer discussed various devices aiming to meet the needs of the slow worker in mathematics. These devices reflected by current practice in institutions offering practice teaching courses are: (1) conferences with teachers and student teachers in hours other than the class period; (2) special supervised classes of study; (3) division of classes into separate sections on the basis of ability; (4) the use of bright students as instructors of the slow students (this device was found to to be in extensive use; a report of an experiment aiming to evaluate this device by testing the effect of classroom communication on the learning process was presented, the objective evidence tending to show that not only was the slow student weakened but the fast worker lost in interest and efficiency); and (5) a definitely organized minimum course of study.

SUPPLEMENTARY DISCUSSION OF (4) AND (5)

Communications from teachers of mathematics received by the writer after the discussion of the foregoing topics raised specific issues relating to the use of fast workers as teachers of the slow

[1] "The Problem of Individual Differences in the Teaching of Secondary-School Mathematics," pp. 535–49.

students, and to a minimum course, which make it necessary that the discussion of these topics be briefly supplemented here.

The first issue, raised with reference to the use of bright students as teachers of the slow students, is stated as follows: The evidence submitted is an attack on the monitorial system. The arguments in favor of the monitorial system are: (*a*) The history of education shows that systems using the monitorial method were generally more efficient than contemporary systems which did not employ the monitorial method. (*b*) All learning from the student's point of view is communication between the learner and the textbook, the teacher, or with other members of the group. In the process of teaching a new principle, communication between members of the group may be more effective than the teacher or the textbook because the student who has just learned the principle will talk in terms of the learner (psychological method), whereas the teacher and the representative textbook talk in logical terms which are foreign to the student's thinking processes.

Obviously the schools referred to in (*a*) are the Lancasterian schools of England[1] and the Jesuit schools.[2] It is admitted that these schools were superior to contemporary systems largely because of the monitorial method. The competing schools were inferior systems lacking organization of the mechanical routine and using the individual-pupil method of instruction. Hence there was little time for teaching. It is axiomatic that the monitorial system is essential to efficiency in manipulating the mechanics of schoolroom procedure. In general, the most efficient teachers devise technique of taking roll, collecting papers, passing papers, ventilating, heating, etc., by reliable pupils under supervision. But the evidence of the reported experiment in the University High School tends to prove that it is false to assume that the efficiency of the monitorial system carries over into the teaching process.

The argument that students discussing a problem in a group talk in terms which are nearer the pupil's comprehension, i.e., the arrangement of material is more psychological, was also vigorously

[1] For description see Parker, *The History of Modern Elementary Education*, pp. 101–7.

[2] See Monroe, *Textbook in the History of Education*, p. 439.

advocated by fellow-students in a graduate class in the University of Chicago. The fact is, as the experiment showed, that what really happens is not teaching at all, but a "showing" process, a driving to the end in view. Beginning practice teachers frequently go through the same "showing" process in attempting to teach: they have the logical arrangement of subject-matter, not the psychological. In my own experience with practice teachers it has been difficult to convince them that the learner approaches the subject in a different way. Again and again a practice teacher will say: "I don't see why I could not drive this thing home when it was so 'dead easy' and in such definitely organized form." The trouble lay in the fact that she had forgotten the inductive propaedeutic development that had led to the easily comprehended mathematical concept in her own mind. She sees the end in view as she drives forward with the class in the attempt to hurdle all intervening steps. Her method, similar to the method of the fast worker, is a showing process, not a teaching process: it is logical not psychological. After a few fatal experiences the practice teacher begins to see what the instructor of her special methods course has been talking about; she realizes that the logical arrangement of subject-matter in her mind must be set aside and be displaced by a new arrangement built up in the light of a practical psychology, which teaches the approach to a concept from the point of view of one who learns versus the method of one who knows. It is possible that the moment the fast worker grasps the mathematical principle his mind throws the subject-matter into logical order. At any rate, the displacements in the tables in the October number tend to show that the slow worker was mentally dragged over the ground and that only the "B" and "B+" students "got the point" in the monitorial system of instruction.

This concludes the supplementary discussion of the monitorial system, which was permitted to grow somewhat lengthy because (*a*) it has gained wide use in current practice without having its validity as a teaching device established; (*b*) it is pedagogically important that its validity be tested by experiments more scientifically controlled than the one described; (*c*) the experiment puts the burden of proof on the group-study advocates. The limit of

diminishing returns seems to be reached at an early stage. It appears to be easy to overwork the informality idea in a classroom. In the past the objection to classroom communication was based on disciplinary grounds; it is entirely probable that further experimentation would result in teachers of mathematics clinging close to the old ideal on an entirely different basis, namely, efficiency.

A reaction to the suggested minimum course seems to be the argument that a standardized minimum course implies too detailed an organization of daily work which would tend to rob the teacher of his individuality. It is true that a minimum course demands a very high degree of organization. It means that every teacher in a department knows what every other is doing day by day; and every pupil has before him a printed outline of specific principles and typical examples which represents the least he must accomplish in order to obtain a mere passing-grade. But the matter of robbing teachers of individuality need not concern us seriously. Recent educational literature has produced considerable "poppycock" on the subject of individuality. It is possible that teachers of mathematics have an enormous surplus supply of individuality as it is commonly interpreted. Bagley[1] and Parker[2] present convincing argument on the point that there is ample scope for the expression of spontaneity, individuality (of the desirable sort), and reasoning within a well-controlled, routinized system. The point is that a great majority of teachers of mathematics could profit considerably by an exchange of that which is cherishingly called individuality for well-defined and accepted standards of procedure. The writer taught three years in the ranks of a system routinized to its minutest details in subject-matter and classroom mechanics, but did not hear a single suggestion that someone had carted off individuality. Individuality has no business inserting or rejecting topics, fixing arbitrary time limits to topics, or determining what principles shall be taught—clearly these are administrative functions. Individuality may come to its own in the actual teaching of a given principle to a given class.

[1] *Classroom Management*, p. 32.

[2] *Methods of Teaching in High Schools*, p. 28.

Up to this point the discussion has been directed so as to supplement current literature aiming to meet the needs of the slow student. The following pages will be devoted to consideration of the fast worker by descriptions of specific devices calculated to meet his needs.

THE FAST WORKER

It will be recalled that the second question asked of critic teachers of mathematics was: "What are you doing for the fast worker?" The replies reflect neglect as contrasted with the sincere efforts directed to help the slow worker. Many critic teachers supplement the formal questionnaire with personal letters in which they were eager to tell what they were doing for the slow student, but the replies relating to the fast worker were expressed in such generalities that they are not worth reproducing here. All of the responses would fall into two groups: (1) use of fast workers as monitors or instructors of slow students; (2) the assigning of supplementary reading-material or interesting problems of greater difficulty. The first has been shown to be a procedure of doubtful value. It will later be shown that current practice makes the second device equally meaningless. With the exception of a few good teachers, and a large number of mediocre teachers who direct their searching to the fast workers, the situation may be summarized as being marked by utter neglect of the needs of the fast worker.

EUROPEAN VERSUS AMERICAN IDEA

But this situation does not prevail in the European schools. The English system, characterized by its complex examination system, and the selective German *Gymnasium*, ever pointed toward picking the leaders, are good examples in which the emphasis is placed at the other end of the problem. This is a striking contrast to the American idea that the secondary school shall do its share in correcting the inequality of physical strength and intellect that nature has imposed upon men. Thus we see a definite reason why our early efforts were directed toward developing the technique of the slow worker when the existence of the problem of individual differences was established in the consciousness of school men.

POSSIBILITIES OF BRIGHT STUDENT

Teachers of mathematics have vaguely recognized the undeveloped mental resources of the bright student, but have usually hoped that he would somehow come to his own in spite of this neglect. It is due to the practical psychologist, Thorndike, and his research students at Columbia that school men realize the possibilities. In chap. vi of his *Principles of Teaching*, Thorndike demonstrates on a statistical basis how great the amount of difference in capacity between the fast and the slow workers really is. His conclusion is that in an ordinary class the brightest tenth will in any one trait have an average ability from one and three-fourths to four times that of the lowest tenth. Pedagogically interpreted this conclusion means that with the ordinary teacher teaching a representative class and directing the work to meet the capacity of the middle group, there are, roughly speaking, a fourth of the students who are being dragged over the ground at so rapid a rate as to be hopelessly confused, and a fourth of the students who could easily do twice as much work.[1] All data collected in various educational experiments support the conclusion and the interpretation. Hence we see the vast possibilities that may be attained by a proper direction of the ability of the fast worker. Concerning the importance of the problem Judd says: "It is time for us to learn to guide those who do excellent work quite as much as those who do a low grade of work."[2]

CLASSIFICATION ON BASIS OF ABILITY

The obvious logical solution to this problem is registration of students in classes on the basis of ability. This means that the fast workers would be grouped into one section. It has been noted in another connection that the high schools which are using this method are enthusiastic in its support. A considerable number of elementary schools are organized on this basis. For a time the University Elementary School organized the classes containing sufficient numbers on this basis. Principal Harry O. Gillet is convinced not only that the plan is the economical one for an elemen-

[1] See Parker, *Methods of Teaching in High Schools*, p. 372.

[2] *Psychology of High-School Subjects*, p. 472.

tary school, but that sooner or later the American high school will be organized on this basis. With the addition of the junior high school such sections could go on without interruption in the high-school work.

The only argument against the plan advanced by those who have not tried it, besides administrative difficulties (in program), is that it might discourage the slow worker, and that the slow sections are difficult to teach. What really happens is that the slow, conscientious plodder is discouraged by the showing of the brilliant students, and by his failure to grasp the material as it flashes past him. If no great ado is made about the social prestige attached to such classification, slow students prefer to work in sections where they can hold their own. Leaders of such sections soon develop as the work moves along with interest as high as in other sections. Nor need any importance be attached to the second argument. A real teacher will welcome the opportunity to try his pedagogy on slow sections. The writer has seen a colleague (Mr. Breslich) teach a demonstration lesson to a very slow section with such enthusiasm and success that the large number of visitors did not even suspect that the class was below standard.

It is only possible to guess the large amount of work a section of bright students could accomplish in four years' work. There are numerous examples published in which sections of fast workers accomplished far more than the usual amount. Parker (p. 382) in the text referred to above describes a school in which "the first section commonly completed Wentworth's *Plane and Solid Geometry* in one year." The writer is convinced that he could give all the work commonly given in two years to a section of fast workers in one year, and that such a section would compare favorably with students of equal ability spending two years in ordinary ungraded classes. Perhaps such a section could do all mathematics through elementary calculus in four years of high school. At any rate the German *Gymnasium* somehow succeeds in saving two years, and it may be largely due to the selective process that eliminates all slow workers.

This classification would greatly stimulate interest. Mathematics teachers are familiar with the intermittent interest of a fast

worker during an inductive development which at times lags to the extent that he may actually miss the finer interrelations but rapidly increases as the rate of progress is accelerated. In the process of picking a Freshman mathematics team (to be described later) twelve of the best mathematics students chosen from a hundred Freshmen in the University High School were given special drill work during hours after school. This group accomplished a marvelous amount of work and the interest never abated. The experience was a convincing argument that the fast workers would profit greatly in quantity and quality of work done if the classification of students were based on capacity.

FORMULA BASED ON EXISTING CONDITIONS

However, current practice does not predict that this method will be greatly employed in the near future. Consequently, mathematics must do the most that can be done to solve the problem of individual difference as it exists in the ordinary class of varying ability. This formula was stated in our last discussion as: (1) regulating the rate of the presentation of new subject-matter to the ability of the majority of the class regardless of the rate at which those at the extremes, the unusually fast or the very slow workers, are able to progress; this is to be accomplished by the recognition of well-defined minimum and maximum standards on the part of the teacher and pupils; (2) providing extra instruction in supervised study for the slow workers; this instruction may be given either as part of the regular recitation, or in a special period which constitutes a part of the regular program; fundamentally this means teaching the slow worker how to study; (3) providing profitable supplementary activities for the fast workers that will stimulate their enthusiasm for the subject and absorb their energy profitably.

FOUR DEVICES

The first two have been discussed. It remains for us to present specific devices that will constitute the supplementary activities for fast workers. These devices are (*a*) mathematics exhibits, (*b*) mathematics clubs, (*c*) interscholastic mathematics contests, and (*d*) a routinized scheme for assigning supplementary reading-material and problems of greater difficulty.

The mathematics exhibit.—Perhaps the most important of these devices is a mathematics exhibit. This device need not be described here in detail. An extensive description by W. D. Reeve may be found in *School and Society* (August 7, 1915). The following quotation conveys the technique of the exhibit:

> The work was begun in the hope that, as material for the exhibit was collected, subsequent plans and actions would be determined. To this end, bulletin boards about five feet long and four feet wide were placed in each of the mathematics classrooms; and upon these boards the work of the different classes in mathematics was posted from day to day in order that the pupils, and also visitors, might observe what was being done.
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> The papers to be posted were chosen on the basis of neatness, importance of subject-matter, care in development of proofs, unusually good independent work, and special reports. These papers were referred to by the instructors from time to time and discussions leading to improvement in future work were carried on in class. In addition to the work of the pupils, any items of mathematical importance secured by either the teachers or the pupils were posted on these boards. In this way great interest was aroused in these classroom exhibits, and the improvement in the general quality and appearance of all written work, to say nothing of the increase in mathematical power, has been ample reward for all the effort expended in organizing and preparing such exhibits.
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> A friendly spirit of rivalry has always existed among the students, and a desire on the part of all to be well represented, especially in the annual mathematics exhibit, has made the work a pleasure. This same spirit gives rise to a desire for independent work of a research type that is a valuable asset in later mathematical work.
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> Various examples of independent work might be mentioned, such as the drawing of trigonometric curves, illustrated reports of problems in surveying, discussion of geometrical and physical paradoxes, attempts to trisect an angle together with a historical account of such attempts, collection of different methods of proof for the same theorem, and many other items akin to what are often subjects for discussion in high-school mathematics clubs, and in which the pupils are vitally interested.

The rest of the article takes up in detail the organization of exhibit material and the general method of building up the exhibit. A permanent exhibit can be made of great interest to all students. It is particularly beneficial to the excellent students who take great interest in making changes from time to time in the exhibit. The Reeve article shows clearly that every mathematics department can

easily build up a valuable permanent exhibit and use it to stimulate the interest and effort of its students.

The mathematics club.—A second device is a mathematics club whose membership consists of students of excellent ability. Mr. Charles W. Newhall of the Shattuck School, Faribault, Minnesota, is credited with having organized the first secondary-school mathematics club, in 1903. His published programs[1] will be found helpful to those who contemplate the organization of a mathematics club. There are three mathematics clubs in the city of Chicago modeled after the Newhall clubs. The members of the Pythagorean Club at Hyde Park High School are particularly vigorous in their activities. This club ranks high as a student activity in this large public high school. Concerning the function of such a club in its relation to the fast worker, Miss Shoesmith, the faculty adviser of the club, in an article about to be published in *Science and Mathematics*, says:

In addition to the problem of arousing the dull or the indifferent pupil from his lethargy there is the difficulty of keeping the brighter and more original pupils working at concert pitch, so that while we are attempting to create interest we may not kill that which already existed. While more intensive work on the subject in hand may be assigned for extra credit to these more ambitious pupils and other devices may be used to retain their interest, still it is a lamentable fact that the amount of uniformity necessary in classroom work makes it difficult to bring out the capacity of the individual pupil. Yet we owe it to the excellent student to hold his interest and by opening up to him new fields of thought inspire him to the development of mathematical power of which he may be unconscious. The mathematics club is at least a partial solution of this difficulty and the work of such a club reacts favorably on the attitude toward mathematics throughout the school.

When the possibility of organizing a small club was proposed these pupils were very enthusiastic. From the high-school student's point of view it was of course imperative that the club be equipped at the outset with constitution, by-laws, a name, and a pin. Regular program meetings, usually an hour and a half in length, are held every two weeks at the close of the school day. The president, usually a Senior mathematics student, presides at the meeting. The program committee confers with the mathematics faculty in regard to the subject-matter of each program and urges club members to propose problems and topics of special interest which they may wish to hear discussed. At each meeting programs for the next meeting are distributed so that members may

[1] See *School Science and Mathematics*, V, 323; XI, 500.

be informed two weeks in advance of the topics which will be up for consideration. A committee on proofs passes on the validity of original solutions and sees to it that these are written up in permanent form and preserved.

The programs are similar to the published programs of Newhall, consisting of problems of historic interest, mathematical fallacies, mathematical recreations, and constructive problems. During the past year two members actually succeeded in obtaining independent and original solutions of the famous theorem of Appolonius, namely, to construct a circle which shall be tangent to three given circles. In order to insure greater freedom and spontaneity in the regular meetings the club holds two social affairs during the year. At these social affairs all of the entertainment is of a mathematical character, consisting of charades, contest games, etc. Members exhibit great cleverness and ingenuity in devising question contests in which all answers are mathematical terms, in producing art exhibits in which guests are to guess well-known propositions and mathematical terms, and in composing weird tales from mathematical symbols to be translated by guests. The writer has used the "art exhibits" produced by the members of the Hyde Park Club, and their ingenuity has greatly stimulated interest.

The club appears to be as enthusiastic today as it was when organized four years ago. In fact, there seems to be a vigorous demand in the student body for the organization of a second mathematics club. The situation appears to have demonstrated the value of a mathematics club.

Finally, it must be admitted that a great deal of the material considered by a mathematics club is available for introduction into the regular recitation periods. Mathematics is a rich field for recreation material. In *School and Science* (April, 1915) Newhall published a complete classified bibliography of recreation material with which every teacher of mathematics should be thoroughly familiar. Much of the material which stimulates the excellent student is even more valuable to the mediocre student and therefore is fit subject-matter for the regular recitation. The opportunity to train students in habits of harmless enjoyment should certainly never be lost, particularly when the subject-matter conveyed helps to build up the regular course. Incidentally it is

important to note that, contrary to the general opinion, mathematics as taught by specialized teachers does give its students genuine enjoyment. The data upon which this opinion has been based have been chosen at random and represent the result of inefficient teaching. Mathematics, like most secondary-school subjects, requires the mastery of a specialized technique and a command of practical pedagogy. Practical training schools have only recently developed. In addition to this situation school executives have too frequently acted on the assumption that anyone reasonably familiar with the subject-matter of secondary-school mathematics can teach the subject. The general results have not been conducive to the greatest possible enjoyment to students. A constructive criticism should be directed at the methods of teaching and the preparation of teachers, and not at the possibilities of the subject. Nor has it always been clear that the teaching in most other subjects is equally deficient or worse. As a member of a committee engaged in the collection of data from thousands of students aimed to reflect the degree to which mathematics contributes to the genuine enjoyment of secondary students, the writer is convinced that trained teachers of mathematics are eager that their work shall be investigated. The data have not been compiled, but the work has progressed far enough to predict that the information will show that mathematics when taught by well-trained teachers ranks high among the subjects which offer genuine enjoyment to secondary-school students.

Interscholastic mathematics contest.—A third device consists of a mathematical contest between classes of the same institution or between picked teams of different institutions. It is a remarkable fact that teachers of academic subjects have never made use of the interscholastic competitive element which is admitted to be a powerful stimulus to effort in athletic contests. An athletic contest develops enthusiasm and ability to the highest degree on the part of the contestants. The question arises whether such contests are equally effective in a purely academic subject.

The writer attempted to answer this question by devising a contest between teams chosen from first-year mathematics classes of two Chicago schools. The teams represented Hyde Park High

School and the University High School. Faculty representatives of the mathematics departments of the two schools formulated detailed rules to govern the contest. The contest involved all the technique of an athletic event: e.g., a preliminary contest, expert judges, score cards, an analyzed system of grading, announcer, time-keepers, final events open to public, teams, captains, substitutes, "rooting" sections, etc.[1]

The try-outs for the teams absorbed for weeks the interest and efforts of every "A" student in the two schools. At the Hyde Park High School the teachers held review contests between the various Freshmen sections. At the University of Chicago High School practice teachers divided the classes into teams and used a fraction of each period for review contests. Team scores and individual scores were posted from day to day. Interest in mathematics ran high in both schools.

The oral contest was held at the University High School on June 4. The audience filled the school's largest room. Only one baseball game on the school's schedule rivaled the contest in numbers and enthusiasm. This large audience attended in spite of the fact that conditions were very unfavorable on the particular day in question. Other school activities competed for the audience. In particular an elaborate garden party, supper, and dance followed the contest. This social affair seriously tempted a large number to remain away. In spite of this the audience "stuck" even after seeming decisive results had been announced. It was certainly a rare and unusual educational scene of "rooting" sections with pencils and pads eagerly following the progress of the teams. The teams were not excited by the audience. There was very little evidence of nervousness after the first few minutes. The University of Chicago High School team averaged twelve years and three months in age, perhaps as young a first-year mathematics team as could be gathered anywhere. This team stood up well in the contest which was close at all times. Hyde Park High School showed remarkable staying powers, holding itself down to steady, consistent work, even after disheartening announcements. The Hyde

[1] For a description of this technique see article by the writer in *School Science and Mathematics*, December 15, 1914.

Park High School team finally won the contest by a score of 2 to 1. The judges graded independently throughout and submitted score cards showing details that agreed substantially in spite of the fact that the contest was exceedingly close throughout; in fact the scores were actually reversed near the close of the contest. The decision was as decisive as that of a hundred-yard dash.

The mathematics faculties agree that the experiment was of great educational significance. Agreements have been reached whereby the two schools will have an annual mathematics meet in the future extending throughout the four years of high-school mathematics. A valuable cup has been donated and will be the object for competition for several years. Some of the technique has been revised slightly and interest will be accelerated.

The experiment is a definite suggestion for other departments. It seems to be entirely possible to have contests in Latin, history, mathematics, or even general interclass contests with as much enthusiasm and profit as an athletic contest.

No doubt there are objections to the scheme, especially if it is not carefully directed. But in this it is like an athletic contest. Its value will depend, as every school activity does, on the degree and quality of faculty direction.

The writer does not wish to exaggerate its significance. It is simply a unique device which may, upon experimentation, prove to be of assistance in the solution of the problem of individual difference inasmuch as it will be a powerful stimulus to the enthusiasm and effort of the "A" student in mathematics.

A routinized scheme for assigning supplementary work.—The survey referred to in the last discussion revealed the device of assigning supplementary material to fast workers as most common in current practice, but in such a form as to be practically useless to all but the exceptional teacher. Critic teachers in letters generally admitted that they had no special technique of assigning such work. Frequently such work takes the form of "busy work," with little thought given to the value of the material as a means of profitably absorbing the energy and accelerating the interest of the bright student. In order to accomplish these two purposes such material needs to be carefully planned beforehand. In the same manner

that the minimum course needs to be standardized and fixed in mind by teacher and slow workers, so also must the maximum requirement be definitely standardized and held up in definite form before the "A" student. The upper and lower limits of work above the passing-mark need definition. In the University of Chicago High School the amount of credit given varies directly as the quality of work varies from fulfilling the requirements of the minimum course to those of the maximum. Thus a student doing "A" (excellent) work for a year gets 1.25 units credit, while the student who does just enough to fulfil the requirements of the minimum course gets but 0.85 of a credit. There are six grades that vary between these limits.[1] It will be noted that the excellent student gets one and one-half times as much credit for the same course as the slow worker, and he thus receives a strong incentive to work at a high level. This varying credit scheme demands that the instructor have clearly defined the basis for this differentiation. In mathematics this basis certainly ought to be more than a difference of grades on examination. It means an outline of a standard course for all grades of students. The subject-matter should consist of a carefully graded list of problems for each major topic and be in such standardized form that the instructor can assign one group to the excellent students, one to the good section, and one to the nearly passing group, etc. In addition the subject-matter of this routinized scheme may well include reports of historic and recreation material described in another section. Miss Beulah Shoesmith, of the Hyde Park High School, employs this scheme far more successfully than any other teacher whose work the writer has seen. She has her own syllabus of geometry problems carefully graded as to difficulty, and at any stage of the course she is able to assign lists of problems of varying difficulty to groups of students of varying abilities. This routinized scheme of supplementary assignment of library work in recreation and historical material or graded lists of problems "on tap" for every topic throughout four years of mathematics is meeting the problem of individual differences in a practical way. But the difficulty lies in the fact that such material is not

[1] For a detailed description of this scheme of varying credit read the statement of Principal Franklin W. Johnson in this number of the *School Review*.

in available form for all teachers. Few teachers have the time, the ability, and the library facilities to organize such material.

THE BIG NEED OF SECONDARY-SCHOOL MATHEMATICS

But this need for organization of supplementary material is subordinate to the big need in mathematics, which is the collecting of devices used in the mechanics of the schoolroom and the best methods of teaching special topics and the organization and publication of this material in available form. This material must be collected from the various schoolroom practices. The publication of a manual of methods as technique, written with this experience as a basis, would serve as a clearing-house for methods and would revolutionize the teaching of mathematics in secondary schools. It is greatly to be desired that some institution interested in the training of secondary-mathematics teachers or some large city school system train at least one efficiency expert in secondary mathematics. But the detailed discussion of this vital need falls outside the limits of this article.

Finally, it is important to realize that the solution of the problem of individual differences as it applies to both slow and fast workers is in an elementary stage. Few problems relating to the secondary school offer such opportunity for improvement in efficiency. The solution must come directly from the schoolroom and at the present time this is the problem that challenges the best efforts of all secondary-school men.